FUNCTION-BASED STREAM RESTORATION PROJECT PROCESS

1. **Programmatic and Design Goals–** The programmatic goals are the big-picture funding driver for a program or agency. Examples of programmatic goals include: Total Maximum Dailey Load allocations, providing stream mitigation credits, restoring listed or candidate species, addressing watershed needs based on a watershed management plan, species restoration for recreation, e.g., trout, and others. Programmatic goals can be linked to regulatory requirements, but can be initiatives developed through voluntary efforts as well.

   The purpose of design goals is to document why the project is being proposed and how it will be completed. This will be accomplished by establishing design goals and objectives. The terms goals and objectives are often used interchangeably; however, there is a difference. Goals are statements about *why* the project or effort is needed. They are general intentions and often cannot be validated. Objectives are more specific. They help explain *how* the project will be completed. They are tangible and can be validated, typically by performance standards. Well-articulated goals and objectives establish a foundation for project success and will be used throughout the entire project process. The first use of established goals determines which watershed parameters and stream functions that will be assessed as part of the functional assessment. After the functional assessment is completed and the restoration potential determined, design objectives (which are quantifiable) are established. Lastly the goals and objectives are used to establish monitoring performance standards. Examples of project goals are in *"A Function-Based Framework for Stream Assessment and Restoration Projects"* (Harman et al) and instructions on how to develop project goals and objectives are provided.

2. **Watershed Assessment –** The purpose of this section is to determine the health of the watershed and its influence on the proposed project area. Typical parameters assessed include: geology, soils, current and future land uses, land cover types, percent impervious surfaces, hydrology, etc. The project goals and objectives will determine which specific parameters will be assessed. However, there will always be some parameters that will be assessed regardless of the project goals and objectives because of their importance in influencing watershed and stream health. This assessment will play a significant role in determining the restoration potential of the proposed project restoration potential.

3. **Reach-Scale Functional Assessment** – The purposes of this section are to establish the existing functional condition, determine stressors, identify constraints, and determine channel evolution. The functional assessment should state for each function assessed whether it is functioning, functioning-at-risk, or not functioning. The project goals and objectives will determine which specific function-based parameters will be assessed. However, there will always be some parameters that will be assessed regardless of the project goals and objectives because of their importance in influencing stream functional condition. Below is an example of a functional assessment table that displays the function-based assessment results in an organized and clear manner. Column1 (level and category) displays the functional category of the parameters being assessed.

   Column 2 (parameters) displays the function-based parameters being assessed. Column 3 (measurement methods) displays the methods used to quantify the function-based parameters. Columns 4 and 5 (pre-restoration value and rating) contain the quantitative value of the function-based parameter that was derived from the measurement methods and functional rating. Columns 6 and 7 (post-restoration condition value and rating) display the predicted function-based parameter value and functional condition. For ease of reading the results, color coding is used to display functional conditions of function-based parameters. Green means the stream is functioning; yellow means functioning at risk; red means not functioning.

4. **Restoration Potential -** The purpose of this section is to determine the highest level of restoration that can be achieved, given the watershed conditions, function-based assessment results, stressors, and constraints. Also, it is at this point, the actual amount of potential functional lift will be determined. For example, the assessment may indicate that a stream reach has severely incised, extreme bank erosion, low bed form diversity, and no riparian vegetation. If this site is in a rural setting (low lateral constraints) with a healthy watershed, then the restoration potential is high because functional lift can likely be achieved for water quality and biological functions. However, if this same site is in an urban area or a setting with lateral constraints like a road or even cropland that cannot be removed from production, then the restoration potential is lower because the functional lift may only occur for fluvial geomorphologic functions and not physicochemical and biological functions. If the project is a mitigation project, functional loss will also be determined at this time.

5. **Design Objectives** – The purpose of this section is to establish design objectives based on the design goals, results of the functional assessment and the site restoration potential. The design objectives reflect the project goals but state specifically how the project will be completed. Thus design objectives are quantifiable and measureable. For example, the project goal may be to increase brook trout populations, but the functional assessment showed that water temperatures were too high to support brook

trout and the site was devoid of riparian vegetation. So a design objective would be to have water temperatures not to exceed 16° C in any given year. The design element could then be to plant riparian vegetation to shade the stream and reduce water temperatures.

6. **Restoration Design Approach & Alternative Analysis –** The purpose of this section is to determine the best restoration design approach that meets the project goals and objectives and the restoration potential of the site. The focus should be on how a design approach could influence stream functions. An alternative analysis of different design approaches should be conducted to determine which approach provides the best results based on: highest functional lift, impacts to existing function, costs etc. At the end of the alternative analysis, detailed design criteria should be developed. A few examples of the design criteria may include: floodplain and channel velocities, frequency of floodplain inundation, radius of curvature ratio, meander width ratio, bank height ratio, maximum slopes, pool to pool spacing, pool max depth ratio, and width to depth ratio.

7. **Design Development –** The purposes of this section are to document the design development approach, ensure project feasibility, determine project implementation costs, and produce a constructible design set along with specifications and materials. A typical design set may include: title sheet, existing conditions, proposed condition, longitudinal profile, structure details, erosion and sediment control, planting plan, grading, and existing and proposed cross sections.

8. **Monitoring –** The purposes of this section are to determine if the quantifiable project objectives are achieved and that existing functioning parameters remain functioning. It is critical that monitoring data be converted into information so that it can easily be used to demonstrate whether the project has met the project goals and objectives. This can be simply done by adding additional columns to the example functional assessment table mentioned in the Site Level Function Assessment section showing the monitoring results.

EXAMPLE - FUNCTIONAL ASSESSMENT TABLE (USFWS-CBFO)

Level and Category	Parameter	Measurement Method	Pre-Restoration Condition		Post-Restoration Condition	
			Value	Rating	Value	Rating
1 - Hydrology	Runoff	HEC RAS	Similar to reference watershed	Functioning	Similar to reference watershed	Functioning
	Flow Duration	HEC RAS	Similar to reference watershed	Functioning	Similar to reference watershed	Functioning
2- Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.5	Not Functioning	1.0	Functioning
		Entrenchment Ratio	1.73	Not Functioning	>2.2	Functioning
3 – Geomorphology	Bed Form diversity	Pool-to-pool spacing	1.5 to 9	Not Functioning	4 to 5	Functioning
		Pool Depth Variability	2.0 to 3.0	Functioning	2.0 to 3.0	Functioning
		Riffle Length to Riffle Width	2.9 to 4.3	Functioning	3 to 5	Functioning
		Riffle Slope to Reach Slope	1.2 to 3.9	Functioning at Risk	1 to 2	Functioning
		Pool Slope to Reach Slope	0.3 to 0.6	Functioning at Risk	0.2 to 0.3	Functioning
		Rosgen	F → C →E	Functioning at Risk	E	Functioning
	Channel Evolution	Simon	Not Functional	Not Functioning	Functional	Functioning
	Riparian Vegetation	Buffer Width based on Beltwidth	0	Not Functioning	300	Functioning
		BEHI/NBS	Mod / Low	Functioning at Risk	Low/Low	Functioning
	Lateral Stability	Lateral Erosion Rate	0.09 yr/ft	Functioning	<0.01	
		Confinement	0.69 to 1.14	Functioning	>1.0	Functioning
		MWR	2.4 to 4.0	Functioning	>3.5	Functioning
		W/D_{proj} /W/D_{ref}	1.4	Functioning at Risk	1.0 to 1.2	Functioning
		Wavelength to Riffle Width	9 to 14	Functioning	7 to 14	Functioning
4 – Physicochemical	Temperature	Temperature probe for one year every 15 minutes	Higher than upstream reference reach; does not meet species requirements	Not Functioning	Same as upstream reach and meets species requirements	Functioning
	pH	pH probe for one year every 15 minutes	6.0	Functioning at Risk	6.8	Functioning
5 – Biology	Macroinvertebrate Communities	VDEQ Biological Inventory	Moderate to slightly Impaired	Functioning at Risk	Not Impaired	Functioning
		MBSS	3	Functioning at Risk	5	Functioning
	Fish Communities	MBSS	3	Functioning at Risk	5	Functioning